A N

INAUGURAL DISSERTATION,

TO DISPROVE THE

EXISTENCE OF MUSCULAR FIBRES IN THE VESSELS.

SUBMITTED TO THE PUBLIC EXAMINATION

OF THE

FACULTY OF PHYSIC,

UNDER THE AUTHORITY OF THE

TRUSTEES OF COLUMBIA COLLEGE

IN THE

STATE OF NEW-YORK:

WILLIAM SAMUEL JOHNSON, LL.D. President;

FOR THE DEGREE OF

DOCTOR OF PHYSIC;

ON THE THIRTIETH DAY OF APRIL, 1793.

BY JOTHAM POST, A.B.
Citizen of the State of New-York.

CRIMINOSA EST CELERITAS IN JUDICANDO.

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TO

RICHARD BAYLEY,

Profeſſor of Anatomy,

AND

WRIGHT POST,

Profeſſor of Surgery,

IN COLUMBIA COLLEGE:

IN

Grateful Teſtimony for their Care and Attention to him, in his Medical Studies,

THIS

DISSERTATION

IS ADDRESSED,

By their Pupil,

The AUTHOR.

Charles Buxton

From his friend

The author

AN

INAUGURAL DISSERTATION, &c.

SINCE the diſcovery of the circulation of the blood, the attention of Phyſiologiſts has been excited to aſcertain the manner in which it is carried on. The heart is univerſally allowed to be the principal moving power; but many ſuppoſing it incapable, of itſelf, of propelling the blood through the ſyſtem, have conjectured means, by which its action might be aſſiſted, and the routine of the circulation facilitated. They have ſuppoſed the veſſels of the ſanguiferous ſyſtem to be encircled by muſcular fibres, which have an alternate contraction and dilatation, by which an additional power is obtained for keeping up and carrying on the circulation.

An examination of this ſubject is of more importance than might at firſt be imagined; for upon a ſuppoſition of the exiſtence of muſcular fibres in the arteries, has been founded an opinion, which is now becoming very general, of the proximate cauſe of

many important diſeaſes.* It is true, ſuch an opinion, at firſt view, exhibits ſome degree of plauſibility; but upon more accurate inveſtigation, it appears to be rather the creature of imagination, than the reſult of impartial obſervation and deliberate reaſoning.

Many eminent characters have made experiments to aſcertain the projectile force of the heart†, ſome of which have made it almoſt inconceivably great, while others have confined it to a ſmaller compaſs. But however they may differ, it is ſtill proved beyond a doubt, that its ſtrength‡ is conſiderable, and to thoſe who are willing to be unbiaſſed by preposſeſſed opinions, ſufficient to propel the blood through every minute ramification of the arteries, and veins, independent of their muſcular power, admitting ſuch. Why then ſhould we fly to the aid of a cauſe, the aſſiſtance of which is not at all requiſite?

The opinion, that muſcular fibres encircling the veſſels are neceſſary for the circulation, moſt probably muſt have originated from conjecture. But conjecture,

* Among theſe, fevers and inflammations hold no inconſiderable rank. See Cullen's Firſt Lines, volume firſt, ſubject pyrexiæ. See Bell and Cullen on the proximate cauſe of inflammation.

† See Hales's Hæmaſtaticks. See Keil's Anatomy, and Calculations on the Force of the Heart, &c.

‡ By the words STRENGTH and POWER, which are uſed throughout this Treatiſe, I would not wiſh to be underſtood to mean any great exertion. The terms are uſed for want of more expreſſive ones.

conjecture, though ſometimes of uſe to the ingenious in the diſcovery of truth, unleſs well ſupported by fact, ſhould never be miſtaken for demonſtration.

The learned Haller,* who has applied much care, and attention to the inveſtigation of phyſiological ſubjects, ſuppoſed the exiſtence of muſcular fibres in the veſſels as requiſite to aſſiſt in carrying on the circulation, yet expreſsly declares that he never could detect any muſcular fibres, nor perceive any contraction, in the arteries, though he had uſed microſcopic inſtruments for that purpoſe. This is a ſingular inſtance of prejudice, to aſſert the eſſentiality, and believe the exiſtence of muſcular fibres in the veſſels, as requiſite for carrying on the circulation, though unſupported, and in a manner contradicted by his own experiments. But what may we not expect from reſearches made to ſupport a favourite hypotheſis!

If, from the preſence of muſcular fibres on the aorta† near its origin from the heart, we infer their exiſtence throughout the ſyſtem of circulation, we may commit an error; for whenever we meet with them there, which, in fact, is but a rare occurrence, they

* Vide experimenta de irritabilitate, ſect. 2d.

† Becauſe in ſome inſtances they have been ſeen on the aorta, the exiſtence of muſcular fibres by analogy has been inferred throughout veſſels of the circulating ſyſtem.

they are moſt probably the conſequence of ſome morbid affection. I am confirmed in this opinion from the following circumſtance. There is in the Anatomical Muſeum of Columbia College, a preparation of an aorta, with an incurvated ſpine. The aorta, juſt below its curvature, has become ſo much enlarged as to form a complete aneuriſmal ſac. Round this ſac, and the parts adjacent to it, there was a numbur of muſcular fibres plainly viſible to the naked eye. But inſtead of forming the middle coat of the aorta, as is generally imagined and aſſerted, they were external to the common looſe cellular coat of the artery, and had very little connection with each other. Neither did thoſe which were on the aorta wholly embrace it. The part moſt remote from the diſeaſe, had not the leaſt appearance of them. From this, and from ſimilar caſes, as well as from the fact, that, in ſubjects really ſound, theſe fibres are not to be diſcovered, we may conclude, that they only exiſt as the conſequence of diſeaſe. For no Phyſiologiſt will deny, that muſcular fibres, or at leaſt what appear to be ſuch, may ariſe from the morbid affection of membranous parts.

I have repeatedly examined the aortæ of oxen, ſheep, and other animals, as well as of human ſubjects; but have never, while in a ſound ſtate, been able to diſcover the leaſt veſtige of muſcular fibres in them.

Upon

Upon the ſuppoſition of the exiſtence of muſcular fibres in the veſſels, as eſſential to the circulation, and an increaſe of their influence as they recede from the heart, I ſuppoſed they might be found in the iliac arteries, but when I examined theſe, not the ſmalleſt appearance could be obſerved to juſtify the opinion. However, ſuppoſing I was not far enough diſtant from the heart, I imagined they might become more evident in the tibial and ſmaller arteries, which could be eaſily ſeen; for, according to the advocates for muſcular power in the veſſels, theſe are leſs under the influence of the heart, and of courſe, the preſence and action of this power become more requiſite: but here again, upon examination, not the leaſt appearance of muſcular fibres could be diſcovered.

Unwilling, however, to relinquiſh the idea, from its being ſo very generally believed, that there was a *ſyſtole* and *diaſtole* in the arteries, becauſe I could not diſcover the preſence of muſcular fibres in them with the naked eye, I ſuppoſed they might be ſo ſmall as to elude the ſight, and that their contraction and dilatation would become evident by their effects. I accordingly attended to the flowing of blood from the carotid arteries of animals; but could not obſerve any ſenſible alteration in the ſtream as it iſſued from their mouths, any farther than that it came forth

forth with an increaſed or diminiſhed velocity, as the heart contracted or dilated. The diameter of the ſtream apparently remained the ſame while the veſſels were in a ſtate of diſtention; nor did the ſides of the veſſels approach each other. This coincides with Doctor Kirkland's* obſervation, that "ſo far are the larger arteries from becoming wider or narrower alternately, that their ſides have not the leaſt motion of this kind, whether the blood flows freely through them, or whether it is interrupted at the extremity of the divided veſſel; which experiment we made to prevent our being miſtaken, by any alteration that might take place from the reſiſtance to the blood being entirely removed; but the ſides of the veſſels were greatly diſtended, yet they were perfectly ſtill and quiet." Inſtead, therefore, of concluding that the veſſels of the ſanguiferous ſyſtem are encircled with muſcular fibres to aſſiſt in the circulation, we are induced to adopt a contrary belief.

If the arteries have muſcular fibres, and are of courſe irritable, they would, before life itſelf becomes extinct, ſhew ſome ſigns of it, when put to the teſt of experiment. But this, however, did not appear; for, having taken a carotid artery from an ox immediately after his throat was cut, I threw into it ſome water,

* See Kirkland's Medico-Chirurgical Treatiſe, volume the firſt, page 309.

water, about the temperature of the blood, but could not obſerve the leaſt contraction in it, unleſs when diſtended; and then, by means of the elaſtic membranes of which it was formed, part of the water would paſs out. I am informed, that an experiment of this kind has been conſidered abſolutely concluſive of the exiſtence of muſcular fibres in the ſanguiferous ſyſtem as eſſential to the circulation of the blood. The concluſion, however, muſt have been haſtily made; for any perſon, who has impartially and carefully attended to the experiment, might have been convinced, that the arteries were elaſtic tubes, and of conſequence, if put upon the ſtretch, muſt neceſſarily contract, and force out the fluid from within, as if by a muſcular contraction; and the velocity of the fluid ruſhing out would be nearly proportionate to the diſtention made.

In order farther to illuſtrate the truth of the opinion, that the aid of muſcular fibres encircling the veſſels of the ſanguiferous ſyſtem is in no wiſe requiſite, or eſſential to the circulation, I laid bare the carotid artery of an ox immediately after his throat was cut, and tied it in two ſeparate places, that between the ligatures the artery might be filled with blood. I then punctured it with a lancet, when the blood, inſtead of being forced out by a contractile and dilating power, as it muſt have done if muſcular

agency

agency had been the cauſe, regularly trickled down the ſides of the veſſel. The artery, however, was not much diſtended; otherwiſe, from the re-action of the elaſtic power, I ſuppoſe the blood would at firſt have iſſued out in a ſtream.

At the Anatomical Theatre of Columbia College I have ſeen Profeſſor Bayley lay bare the carotid artery of a dog, nearly three inches in length, in order to aſcertain whether it would contract or not. We examined it with cloſe attention, but could not perceive any motion in it, either of contraction or dilatation.* This, too, perfectly agrees with what Haller himſelf obſerves; "for upon examining the circulation in animals with a microſcope, I have never obſerved any contraction in the arteries. I have viewed the circulation for whole hours in fiſhes and frogs, and during the whole time the ſides of the veſſels remained as quiet as thoſe of the tube with which I examined them." Doctor Kirkland's experiments on the ſame ſubject coincide with thoſe of Haller.†

So far experiments ſeem directly concluſive, that the arteries and veins, excepting their elaſticity, are paſſive conductors to their contained fluids. Obſervation

* The pulſe, however, was plainly felt at every contraction of the heart.

† See Kirkland's Medico-Chirurgical Enquiry, volume firſt, page 310.

vation and reaſon may afford us many more arguments to confirm the opinion.

From the ſtructure of the heart, we may draw very forcible reaſons, to induce us to believe, that the arteries and veins afford no other aſſiſtance in the circulation, than that which ariſes from their elaſticity. The right ventricle, compared with the left, has but very little ſtrength. It has not to ſend the blood ſo great a diſtance, nor through ſo complicated a courſe, and therefore ſo much ſtrength is not neceſſary. But the left ventricle, which has to propel the blood through the moſt diſtant parts of the body, as well as thoſe which are leſs remote, has its power proportionably greater. Does not this great diſproportion in the ſtrength of the ventricles afford us a ſtriking argument in favour of the opinion, that Nature has placed in the heart the ſeparate power of carrying on the circulation?

If the arteries and veins are endowed with a power for carrying forward their own contents, why the neceſſity of a heart endowed with ſo much muſcular force? or, indeed, why the neceſſity of a heart at all? Let the blood be but placed in the arteries and veins, and they of themſelves would be capacitated to keep up the circulation.

Had the arteries been originally deſigned to have had a contractile and dilating power from the influence of muſcular fibres encircling them, ſome more convenient method might have been taken to bring them into action. We cannot ſuppoſe that Nature, ever regular and ſimple, would perform her functions by indirect and complicated means in man, her favourite, eſpecially where complication appears entirely unneceſſary. But this would evidently appear to have been the caſe, ſhould we allow the exiſtence of muſcular fibres in the veſſels; for between the coat which is ſaid to be muſcular, and the blood which is to excite it into action, is interpoſed a firm denſe membrane.* Membranes, in a ſound ſtate, are inſenſible:† Therefore, if the arteries have muſcular fibres ſeparated by this inſenſible body from the blood which is to act upon them, they cannot be brought into action by any direct means; and to ſuppoſe that Nature ever deſigned much farther aſſiſtance in the circulation, than that which ariſes from the heart, connected with the elaſticity of the veſſels, is detracting from her perfections. If farther aſſiſtance was requiſite, why were not the veſſels made into hollow muſcles?

Nature

* See Haller's Firſt Lines, ſection 31. See Falconar's Synopſis, page 16.

† Noted from Profeſſor Bayley's lecture on membranes, and membranous parts.

Nature is invariably the ſame in her different ſpecies of creation; and hence, if muſcular fibres have been ſeen in the veſſels of one animal in a natural ſtate, it is preſumable that they would be demonſtrable in another of the ſame ſpecies, which is contradictory to experience.

On peruſing ſome notes taken from Doctor William Hunter's lectures in 1771, I find that he does not admit of any other aſſiſtance from the veſſels of the ſanguiferous ſyſtem, excepting their elaſticity, than as they ſerve to conduct the blood to the various places to which it is deſtined. He ſuppoſes the heart to be an agent in the circulation, and that in general it exerciſes but little of its ſtrength. However, he ſuppoſes what he calls *nervous energy* to have much influence, and that the circulation in ordinary caſes is almoſt wholly carried on by it. The authority of ſo great a man, in diſcarding the idea of the exiſtence of muſcular fibres in the veſſels to aſſiſt the circulation, ſhould have great weight; for he never would have inculcated ſuch a doctrine, had he not been confirmed in it by actual obſervation and reaſoning.

Doctor Whytt,* who has written ſo learnedly on the vital and involuntary motions, when ſpeaking of the

* See his Obſervations on the Vital and Involuntary Motions, ſubject, ſyſtole and diaſtole of the arteries.

the ſyſtole and diaſtole of the arteries, attributes their contraction principally to their elaſticity. He appears to have adopted the notion of the preſence of muſcular fibres in them, only becauſe it had been ſo generally believed,* without really enquiring into the merits or demerits of the hypotheſis.

Mr. Winſlow, when ſpeaking of the circulation of the blood through the liver, appears to have adopted the notion of the paſſage of the blood through the veſſels without the aid of muſcular fibres; for he obſerves, that thoſe "three kinds of venal blood† meet in the trunk of the vena portæ ventralis, where they are mixed together, and from thence they enter the tranſverſe ſinus or trunk of the vena portæ hepatica. In this ſinus they are ſtill more intimately mixed, as in a kind of lake, and become one uniform maſs of blood, which being forced into the branches of the vena portæ hepatica only by the ſupervening blood from the other vena portæ, and by the lateral pulſations of the ramifications of the hepatic artery, its courſe muſt be very ſlow."‡

The

* This is often the caſe, that becauſe an opinion is generally prevalent we readily ſubſcribe to it, whether right or wrong.

† The blood from the ſpleen, pancreas, and inteſtines.

‡ The ſlowneſs of the circulation here, however more probably, ariſes from the greater capacity of the veins compared to the arteries, which carry blood to the abdominal viſcera.

The manner in which the blood paſſes from the ventricles, and is received by the auricles, will alſo favour the idea, that the heart is the ſimple engine for carrying on the circulation. Both ventricles contract, and both auricles dilate at the ſame inſtant;* and ſo much blood as is ſent from the former, is received by the latter. The reaſon of this may appear evident, when we conſider that the arteries and veins are in direct continuation, and conſidered as one continued tube, filled with a fluid which keeps them in a ſtate of diſtention; and therefore, whatever cauſe ſhould propel this fluid from the heart in the courſe of the arteries, will of neceſſity cauſe ſo much as is propelled to paſs out of the veins.† Now, the ventricles propel; and as much as they propel, ſo much the auricles receive. This proceſs muſt continue, independent of muſcular aſſiſtance from fibres ſurrounding the veſſels to aid the circulation, as long as the heart is capable of continuing its action.‡

Since,

* Utriuſque AURICULÆ contractio eodem tempore perficetur, relaxato tunc utroque VENTRICULO, et hi rurſus eodem tempore ſe contrahunt auriculis ſimul relaxatis. Vide Conſpect. Medicin. Theoret. auctore Jacobo Gregory, ſection 419.

† Hence we may ſee, why in aneuriſms there is an interrupted pulſe.

‡ We may hence ſee why, after blood has been drawn from the body, when there has been a great plethora, the pulſe becomes ſo much more full, free, and eaſy, as the heart has a better opportunity of performing its office.

Since, according to the muſcular hypotheſis, ſome other power is wanting beſides the heart; and ſince an increaſe of that power becomes more requiſite in thoſe parts which are more diſtant from the center of the circulation, the arteries, which are called capillary, ſhould be furniſhed with muſcular fibres, which, did they exiſt, would be eaſily demonſtrable, and the veins, from an external view, would repreſent nothing but mere fleſhy cylinders. This, however, is contradicted by experience; for the coats of the capillary, or extreme arteries, are ſo thin and delicate as to become perfectly tranſparent, and the veins, to appearance, are entirely deſtitute of the leaſt veſtige of muſcular fibres; neither has demonſtration ever proved the exiſtence of muſcular fibres in them.

If we admit the exiſtence of muſcular fibres in the ſanguiferous ſyſtem as requiſite for the circulation, it cannot be readily conceived how the blood retains its progreſſive motion; nor can it be conceived how muſcular fibres produce this effect: for if they are "actuated to their office by a ſtimulus, they are incapable of being ſuddenly lengthened by it, and being irritated, they inſtantaneouſly ſhorten themſelves, and ſpontaneouſly return again to their natural ſtate, when the irritating cauſe ceaſes to act."*

They

* See Kirkland's Medico-Chirurgical Enquiry, ſubject, inflammation in general, page 260.

They are then as likely to repel, as to propel the blood. This moſt probably would be the caſe, if the fibres contracted throughout the ſyſtem at the ſame time; for at every attempt made by the heart to ſend forward the blood, the reſiſtance would be proportionably increaſed, becauſe the veſſels would become more full, and of courſe increaſe the action of their muſcular fibres by its ſtimulus; and ſo, inſtead of allowing the veſſels to dilate, and the blood to be tranſmitted with greater eaſe, they would leſſen their diameters, and have a tendency to impede the circulation altogether. Neither can we ſuppoſe, that, if muſcular fibres are preſent, they perform their office by an undulatory or periſtaltic motion, which, in fact, would be ſomewhat the moſt plauſible ſuppoſition, if we are allowed to reaſon from analogy. Thus the inteſtinal tube, which has to convey its contents for different purpoſes, is particularly noticed for its periſtaltic motion, which may be eaſily demonſtrated. But it has never yet appeared in the arteries; neither could it exiſt in them, unleſs the velocity of its motion was equal to that of the blood itſelf. But ſuch a ſuppoſition is vague and hypothetical. I preſume, admitting its exiſtence as a fact, ſuch a motion might be diſcovered by taking an artery between the thumb and finger. I endeavoured to aſcertain this by the experiment in which Profeſ-

ſor

for Bayley laid bare the carotid artery of the above mentioned dog, as well as in other inſtances, but did not ſucceed.

If muſcular fibres do really exiſt in the arteries to aſſiſt in the circulation, their contraction and dilatation would ceaſe when the nervous influence, which capacitated them for action, is taken away. It will be difficult then to conceive how the circulation is continued in paralytic caſes, particularly in the more general affections; for in theſe, nervous energy is deſtroyed almoſt throughout the body, and muſcular motion of courſe interrupted. It may be aſked, then, why the heart continues its action? why does it not partake of the general morbid affection? The reaſon is evident; becauſe moſt of its nerves ariſe directly from the brain; and therefore, while the brain is in any degree capable of performing its function, the heart will continue its action.* Hence we may account for the almoſt total temporary ſuſpenſion of the vital powers in ſyncope.†

There

* This vis inſita of Haller may alſo have an aiding power.

† I have been favoured with the following caſe, which will hereafter be publiſhed more at large, and will have conſiderable effect in confuting the idea of the preſence and action of muſcular fibres to aid the circulation. There is a man now living in this city, who fell head-foremoſt from a load of hay, by which the weight of his body was loſt on the baſis of the ſkull. The ſpinal marrow was concuſſed; in conſequence of which a very general paralyſis followed, attended with a diſordered ſtate of ſeveral of the functions. But notwithſtanding this general affection laſted for ſeveral weeks, the circulation of the blood continued undiſturbed. The

There is a wide difference between the ſtructure of the heart and that of the blood-veſſels; and what brings the former into action cannot have the ſame effect upon the latter. That the properties of the heart and arteries are different from each other, both before and after death, muſt be plainly viſible to any one who has attended to their appearances; for the heart, like other muſcles of the body, when life becomes extinct, remains ſoft and flaccid, while the arteries continue to retain their elaſticity. They yield on the application of a diſtending cauſe, and reſume their former ſtate upon its removal. That the arteries alſo differ from the heart in a living ſtate muſt be evident, becauſe they appear not to be affected by the ſame cauſes which affect other muſcles of the body. What foundation then can there be in the ſuppoſition, that the heart and arteries, ſo diſcordant in their nature, were deſtined to perform ſimilar offices?

Some ſuppoſe the coats of the arteries to be muſcular, becauſe of their ſtrength and thickneſs. This, however, moſt probably ariſes from the continued pulſation of the blood againſt their ſides, becauſe, in

 infancy

pulſe was as free and eaſy as before the injury; and blood drawn from a vein, flowed with its uſual celerity. In what manner could the circulation in this caſe have been aided by the action of muſcular fibres, which receive their influence from the nerves? The nerves were incapacitated for action.—Innumerable inſtances of this kind could be given.

infancy the coats of the arterial and venal ſyſtems are nearly of an equal thickneſs. But if muſcular fibres in the veſſels are really eſſential to the circulation, the veins require them more than the arteries, ſince they are leſs under the influence of the heart; and therefore they ſhould have been thicker, which is contrary to experience.

When a degree of inanition is produced in the ſyſtem, the arteries, from their elaſticity, will contract conſiderably, though they do not embrace the blood ſo ſtrongly as before. The circulation, however, continues, which cannot be attributed to the action of muſcular fibres, even admitting their exiſtence in the veſſels; for it is difficult to conceive how they poſſeſs the property of performing their office equally in one ſtate of the arteries as in another. Yet ſuch is the belief of ſome who cannot relinquiſh a former opinion, too deeply rooted by prejudice, for one which is more plain, more characteriſtic of the ſimplicity of nature. But it is the diſpoſition of man too often to graſp at things beyond the reach of comprehenſion, and to neglect thoſe which might be plain and evident to his ſenſes.

We may be farther convinced, that the heart is the organ for carrying on the circulation, from the pulſe, which is always affected by the ſmalleſt alteration

tion produced in the action of the heart. Thus, if the pulſe be ſtrong, we judge that the action of the heart is ſtrong: If the action of the heart be weak, the pulſe is weak; if irregular, it is indicated by the pulſe; and ſhould its action ceaſe altogether, the pulſe is no more. Further, although the action of the heart continues, ſhould there be a ſtoppage made to the courſe of the blood in an artery, the pulſe is inſtantaneouſly deſtroyed. Thus, if preſſure be made on the inguinal artery ſufficient to ſtop the paſſage of the blood; at the inſtant that it is ſtopped, the pulſe below is immediately deſtroyed, and inſtantly returns again when the preſſure is removed. Now, if there were muſcular fibres encircling the veſſels, and having a command over them, we cannot rationally ſuppoſe that the ſtate of the pulſe would ſo invariably be regulated by the action of the heart. The phænomena which appear in a regular and uninterrupted circulation of the blood, may be imitated by a hydraulic machine. Thus the common pump, for inſtance, may repreſent the heart, and tubes leading from it, the arteries; in which may be felt a pulſe, when the pump is in action, ſimilar to that produced by the action of the heart itſelf.

From the fact, that the arteries and veins are mere paſſive conductors to their contained fluids, abſtracting from their elaſticity, we can eaſily explain,

plain, why, when an animal dies from having its throat cut, and life itſelf becomes extinct, the blood ſtill continues to flow; for, from the elaſticity of the veſſels, their diameters will be continually leſſening as the blood has an opportunity of eſcaping; and of courſe, until the arteries acquire their ſmalleſt diameters, the blood will be continually and regularly flowing through the given outlet. But if the blood gives a ſtimulus to the veſſels, and they are of courſe irritable from the muſcular fibres ſurrounding them, this appearance will never take place; for as long as they contain blood, and continue irritable, it will be forced out in a greater or leſs quantity, as the fibres contract or dilate.

If muſcular fibres were abſolutely neceſſary to carry on the circulation, they muſt of neceſſity perform their office by alternations of contraction and dilatation. The blood then, of conſequence, ſhould paſs out of every veſſel, both vein and artery, *per ſaltum*; which is well known to be contradicted by experience: for the very minute branches of arteries, particularly thoſe in the more remote parts of the body, when divided, will not pour out their blood at firſt *per ſaltum*, but in one continued ſtream, as we ſhould *a priori* have ſuppoſed, from the idea that the veſſels, abſtracting from their elaſticity, are paſſive conductors to their contained fluids; but when the

the parts adjacent to the divided artery become ſomewhat emptied through the given outlet, the blood ruſhes out *per ſaltum*, becauſe they become more full and turgid at every ſyſtole of the heart. If there was a contraction and dilatation in the veſſels, it ſhould become evident in the veins, as they are ſo far diſtant from the influence of the heart; and, of neceſſity, the blood ſhould paſs out in theſe *per ſaltum*. But the appearance of the blood iſſuing from the orifice of a vein in blood-letting, entirely contradicts this opinion.* Indeed, theſe two facts, that the blood iſſues from the extreme arteries at firſt, and from the veins moſt generally, in a continued ſtream, might be conſidered as abſolutely concluſive of the *non-exiſtence* of muſcular fibres in the ſyſtem to aid the circulation; for did they exiſt, the blood muſt always be forced out with an increaſed or diminiſhed velocity, according to their contraction or dilatation.

So ſtrongly does common ſenſe confirm us in the belief of elaſticity in the arteries, that in common expreſſions we are forced to mention it to expreſs or explain our ideas. Thus, the celebrated Doctor Cullen, who has taken ſo much pains to maintain the idea of a ſpaſmodic affection of the extreme arteries

* There may be inſtances in which the blood will paſs out of the veins as if from arteries, as is ſometimes the caſe when there is a very ſtrong, briſk circulation. It alſo happens if the vein be ſituated in contact with an artery.

teries in fevers, obſerves, that their being "elaſtic, and conſtantly endeavouring to contract themſelves, they muſt, on withdrawing the diſtending force, or, in other words, upon a diminution of the quantity of fluids, be in proportion contracted and diminiſhed in their ſize: and it may be further obſerved, that as each part of the vaſcular ſyſtem communicates with every other part of it; ſo every degree of diminution of the quantity of fluid in any one part, muſt in proportion diminiſh the bulk of the vaſcular ſyſtem, and conſequently of the whole body."* And why ſhall we complicate the works of Nature, by adding muſcular influence, in this inſtance, to the elaſticity of the veſſels?

Let us revert to the probable intention of Nature in this inſtance. Can it be rationally ſuppoſed that a multiplicity of co-operating cauſes would have been brought in to produce an effect, which could have been equally produced by one alone? Would the watch-maker render the machinery of a watch ſo complicated, could his deſigned intention be anſwered by greater ſimplicity? Inſtances are not wanting, in which there could not poſſibly have been any other cauſe to influence the circulation than the heart alone; for the arterial ſyſtem has been found almoſt completely oſſified, ſo that the arteries were no more than

* See his Firſt Lines, vol. iv. ſect. 1504.

than bony tubes. Morgagni has noticed this in his celebrated work.* He relates caſes which he himſelf ſaw, and mentions ſeveral authors who had obſerved the ſame circumſtance.† The arteries, in thoſe caſes, could have ſerved no other purpoſe than that of conducting the blood through the different parts of the body. How then could the patient poſſibly have lived a day, if the preſence of muſcular fibres in the arterial ſyſtem, and their action for carrying on the circulation, had been abſolutely eſſential? There are arteries running through the ſubſtance of bones, having their external coats cloſely adhering to them in their courſe, and conſequently incapable of contractility. In what manner then does the blood circulate through the bones, where there can be no contraction or dilatation? And ſurely the circulation, in ſome of the ſmaller bones, is as remote from the heart, as any of the capillary veſſels whatever.

Some, at a loſs to account for the circulation of the blood in the extreme arteries and veins, have had recourſe to the aid of capillary attraction;‡ others, to

* See his obſervations on the arteries in his twentieth letter.

† There is now in the Anatomical Muſeum of Columbia College, the remains of a preparation, in which the arteries throughout the ſyſtem were oſſified. The perſon had lived many years, and died in an advanced age.

‡ See Martin's Philoſophy, ſubject, capillary attraction.

to the assistance of the electric aura.* That the circulation cannot be assisted by capillary attraction, is evident; if it was, there never would be a discontinuance of the circulation while the organization of the body remained entire. The capillary influence would always have the same effect; that of keeping up the motion of the blood, which is contradicted by fact. Neither can we rationally suppose the electric aura to be productive of much benefit in the circulation, as the body is but rarely in such a situation as to be positively electrified; and unless it is positively electrified, the electric aura can have no effect in accelerating the passage of the blood through the vessels.

From this review of the subject, which I trust is founded on just observation and impartial reasoning, we may be induced to deny the existence of muscular fibres in the vessels of the sanguiferous system as essential to the circulation. The arguments here offered are founded on simplicity, the principal characteristic of Nature; and when reason and experience confirm the truth, it is improper to be governed by mere assertion or hypothesis, however plausible, or under whatever sanction they may appear. Let us study Nature to ascertain the manner in which her works are carried on; and while we implicitly

* See Kirkland's Medico-Chirurgical Treatise, page 295.

implicitly follow this method; while we deduce our obſervations from fact alone, or reaſoning, founded upon incontrovertible analogy, we may be more likely to diſcover the truth. Let no one condemn me, in thus having endeavoured impartially to inveſtigate a ſubject which may be of much more importance than we at preſent are aware of. Let thoſe who may peruſe theſe few obſervations, candidly examine the principles upon which they are founded, before they juſtify or condemn them; and while calm deliberation takes the lead of haſty concluſion, they will have cauſe rather to confirm, than invalidate the opinion, that the arteries and veins, excepting the power reſulting from their elaſticity, are nothing more than paſſive conductors to the blood through the various parts of the ſyſtem.*

* I have purpoſely avoided ſpeaking any thing on the manner in which the chyle and lymph get into the blood, for the want of opportunities to inveſtigate it. But as it appears to me at preſent, the mouths of the abſorbents are to their ſyſtem, what the heart is to the ſanguiferous. I have alſo avoided attempts to explain any of the phænomena, explicable by the ſuppoſition of the increaſed action of the veſſels of a particular part. The bounds preſcribed to this Treatiſe are too ſmall to admit them; and ſhould there be any which at preſent are not explicable without a belief of muſcularity in the veſſels, though in theſe caſes they are explained by a ſuppoſition, it ſtill does not follow that our principles muſt fall; for it cannot be ſuppoſed that man, who is an imperfect being, can be adequate to the explanation of all the phænomena of Nature.

FINIS.